RENOGY

THE FUTURE OF CLEAN ENERGY

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1 INTRODUCTION

A new **RENOGY** Off-Grid Solar Kit will provide you with a clean, silent, and sustainable way of ensuring that batteries are fully charged and capable of providing a continuous supply of electricity. Each kit comes equipped with a high quality solar panel that features highly efficient silicon solar cells. If you have purchased a **RENOGY** Off-Grid Solar Kit, a PWM Solar Charge Controller is also included in the package. This controller will serve as a connector between the solar panel and the batteries. The solar charge controller will ensure that the battery is charged with the appropriate amount of solar power as per the battery manufacturer's recommendations. The solar charge controller 'charging states' are optimized to meet the requirements of most standard lead acid batteries as well as flooded batteries. The **RENOGY** Off-Grid Solar Kit also includes a mounting system comprised of sturdy aluminum Z-Brackets as well as the nuts and bolts required to flat mount a solar panel onto a roof or any other flat surface. If you wish to optimize your panel's collection of sunlight by tilting the panel to a different inclination, an adjustable tilt-mount may be purchased separately.

This manual will provide you with instructions on how to assemble the various components of a **RENOGY** Off-Grid Solar Kit. Please refer to the separate Renogy Solar Charge Controller Manual for detailed information about the installation, operation, and programming of the solar charge controller.

Please read the manual carefully before installing or operating the solar kit to prevent personal injury or damage to the components. If you have any concerns about the suitability of the kit for your application, or doubts about any of the instructions in this manual, please contact RENOGY Support at **1-800-330-8678**.

2 GENERAL SAFETY

Warning!

Please read the instruction manual carefully before attempting to carry out any installation or wiring. Contact Technical support for any questions concerning the installation.

2.1 Installation and wiring compliance

Installation and wiring must comply with the local and National Electrical Codes and must be done by a certified electrician. Please follow these four steps:

1. Disconnect all power sources before carrying out the installation.
2. Make sure the correct polarity is observed when making connections between the solar panel, charge controller, and battery. Damage due to reverse polarity connection is not covered by warranty.
3. Make sure all wire connections are secured; loose connections may cause sparks.
4. Wear appropriate clothing and safety gear including protective eyewear when performing any electrical installation.

2.2 Preventing fire and explosion hazards

Working with electronic/electrical equipment may produce arcs or sparks. Thus, such equipment should not be used in areas where there are flammable materials or gases requiring ignition protected equipment. These areas may include spaces containing gasoline-powered machinery, fuel tanks, and battery compartments.

2.3 Precautions when working with batteries

- Batteries contain very corrosive diluted sulfuric acid as electrolyte. Precautions should be taken to prevent contact with skin, eyes, or clothing.
- Batteries generate hydrogen and oxygen during charging, resulting in the evolution of an explosive gas mixture.
- Care should be taken to ventilate the battery area and follow the battery manufacturer's recommendations. Never smoke or allow a spark or flame near the batteries.
- Use caution to reduce the risk of dropping a metal tool on the battery. It could spark or short circuit the battery or other electrical parts and could cause an explosion.
- Remove metal items such as rings, bracelets, and watches when working with batteries. The batteries can produce a short circuit current high enough to weld a ring or similar object to the metal, causing a severe burn.
- If you need to remove a battery, always remove the ground terminal from the battery first. Make sure that all the accessories are off so that you do not cause a spark.
- Only use properly insulated tools when making battery connections.

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2.4 Precautions when working with solar panels

With the incidence of sunlight or other light sources on all solar panels, a voltage appears at the output terminals of the solar panel turning it into a source of electricity. To avoid a shock hazard, make sure the solar panel is covered with an opaque (dark) material such as paper or cloth during the installation. Do not make contact with the terminals when the panel is exposed to sunlight or any other light source.

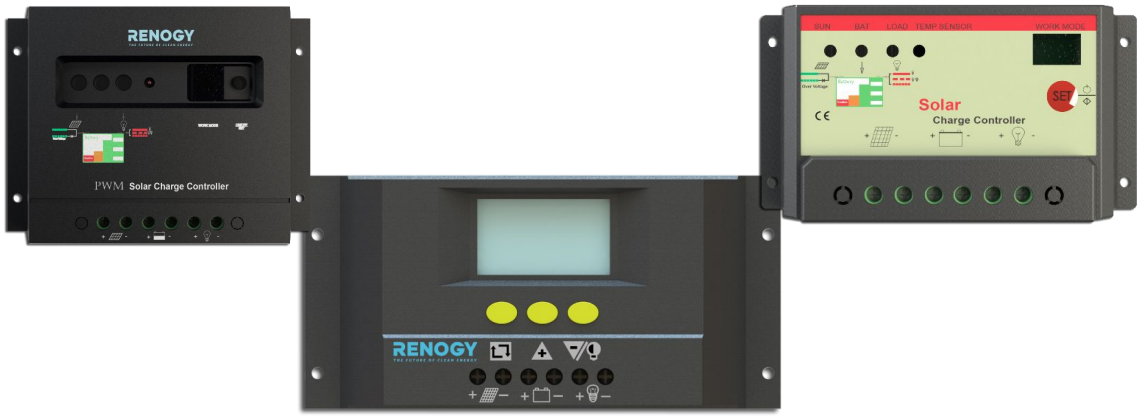
2.5 Precautions when working with charge controllers

If two or more solar panels are connected in a series/parallel make sure that the sum of the short circuit current ratings of all panel strings does not exceed 80% of the charge controller's current rating (i.e. 24A for the 30A charge controller). The open circuit voltage of the solar array (i.e. the maximum voltage across the array) should not exceed 26V when the 12V setting on the charge controller is used, and may not exceed 52V when the 24V setting on the charge controller is used.

2.6 Routine maintenance

- Inspect the solar panels and make sure the surfaces are free from dust, dirt, and other debris; clean with a wet cloth or glass cleaner if necessary.
- Check to make sure all structural components, mechanical fasteners, and electrical connections are secure, clean, and corrosion-free.
- Check and maintain the battery electrolyte levels at regular intervals as per the battery manufacturer's recommendations if flooded wet cell lead acid batteries are used.
- Check and replace damaged components if necessary

3 CHARGE CONTROLLER INSTALLATION



The **RENOGY** Starter and RV Kits come with a PWM- type charge controller to optimally charge your batteries from solar power. Each charge controller comes with a separate detailed manual. It is recommended that you read the solar charge controller manual in detail. The instructions in this section are only a brief summary of the information contained in the manual. Make sure the solar panels and batteries are disconnected from the charge controller before mounting the charge controller.

3.1 Mounting location

The charge controller should ideally be located in an area relatively close to the battery and should be mounted indoors in a dry location.

When mounting the charge controller, ensure free airflow through the controller heat sink. There should be at least 4 inches of clearance above and below the controller to allow cooling. If mounted in an enclosure, ventilation is highly recommended.

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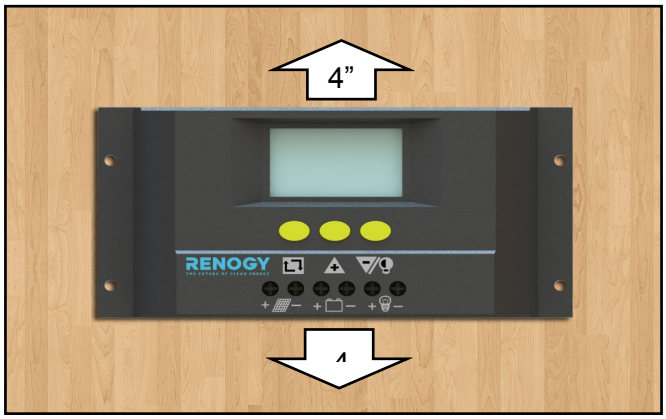

Figure 3.1 Charge controller clearance

Ensure that the mounting location is protected from direct sunlight, high temperature, and water; make sure that the location has sufficient room to run wires.

3.2 Marking and drilling the holes

Use a pencil or pen to mark the four holes on the mounting surface. Remove the controller, and drill the holes in the marked location. Make sure that the holes are sized appropriately to avoid loose screws. If you are mounting the controller on drywall, it is recommended that you use expansion anchors.

Figure 3.2 Hand drill, pencil and charge controller

3.3 Securing the controller

Once you have drilled the holes, place the controller on the surface and align the mounting holes with the drilled holes. Secure the controller in place using mounting screws (not included).

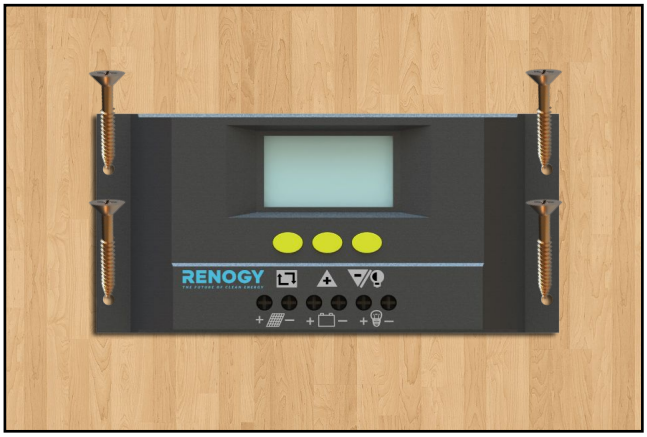

Figure 3.3 Securing the controller with mounting screws

Once the charge controller is mounted, we can show the multiple types of solar panel mounting systems. Please read the following section to learn more about the mounting system that RENOGY offers.

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4 MOUNTING SYSTEMS

In this section we are going to cover the basics for mounting 12V solar panels using the following:

- RENOGY Mounting Z-Bracket
- RENOGY Rail Mount System
- RENOGY Single Pole Mount System

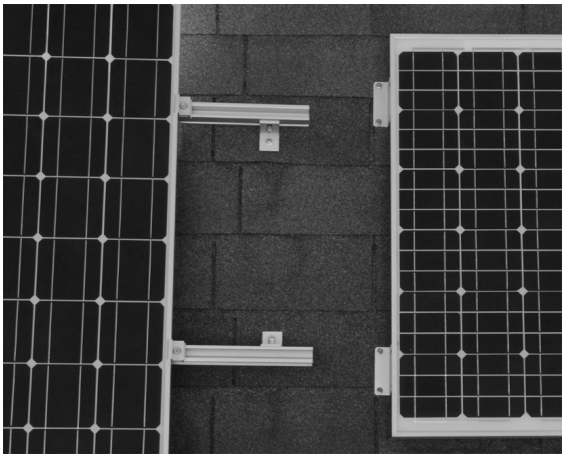

Figure 4.1 Rail Mount vs. Z-Bracket

4.1 RENOGY Mounting Z-Bracket

Figure 4.2 RENOGY Mounting Z-Bracket

Using Z-Brackets for 12V off-grid solar panels is the easiest method to mount the modules on roofs, RVs, cabins, or any other place where a screw can easily penetrate. One set of Z-Brackets is used per panel (four per set).

Using Z-Brackets on an RV roof: "Flat Mount"

When mounting a panel using RENOGY Z-Brackets, a well-nut (also known as "expansion nut") is often used on a pre-drilled hole. This procedure safely secures the panel on thin RV roofs. Using a well-nut is recommended, as the rubber expansion prevents water leakage. The Z-Bracket set does not include well nuts, and they must be purchased separately.

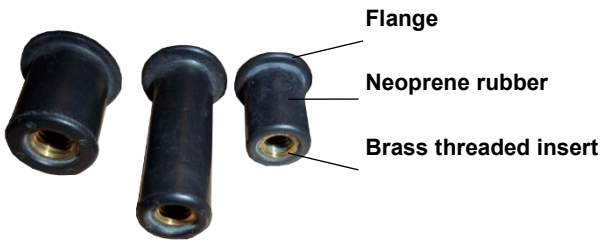

Figure 4.3 Types of well-nuts and their composition

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It is recommended that the roof is at least 3/8" thick to achieve a strong hold of the solar module. The following example involves mounting an RNG-100D module on a 3/8” RV roof.

Parts needed	Parts included with Z-brackets
4x #10-32x3/4” machine screws with round head 4x #10 lock washer 4x #10 flat washer 4x #10-32x5/8” Well nut (aka Expansion nuts) anti-seize lubricant	4x M6x1.0 bracket bolts 4x M6 flat washer 4x Lock washer 4x M6x1.0 nuts

Tools required:

- Hand drill
- 3/8” Drill bit (size depends on the body diameter of the well nut)
- Socket wrench
- 10mm socket
- Phillips screw driver (flat head if using combination drive machine screws)
- Caulking gun with waterproof caulk (or sealant approved by your RV dealer).

Step 1: Attaching the Z-Bracket to a solar panel

Locate the mounting holes on the solar panel. **RENOGY** Solar Panels have four mounting holes on each side.

Figure 4.4 RNG-100D with Z-Brackets attached

It is recommended that the outer mounting holes be used as shown in **Figure 4.4**. Please refer to **Figure 4.6** for instructions on the proper order to mount the hardware. First, insert the M6x1.0 bracket bolt included in the kit, with the head on the inside of the frame. Place the Z-Bracket over the bracket bolt, followed by the M6 flat washer and the lock washer. Insert the M6x1.0 nut and fasten it with your fingers to hold it place. Use a socket wrench with a 10mm socket to torque the nut at ___ lbs/ft. (do not over-tighten).

Step 2: Mark and drill holes

With the Z-Brackets attached to the frame, the panel can be laid on a mounting surface, making it easier to mark the holes for the well-nut.

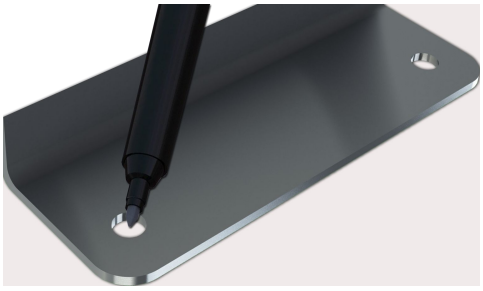

Figure 4.5 Marking the holes to be drilled

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Once the holes are properly marked, use the appropriate size bit to drill the holes. The well-nuts used in this example had a body diameter of 3/8”, therefore, we used a 3/8” drill bit. Carefully drill the holes, and make sure the well-nut fits properly.

Step 3: Attaching the panel to the roof

Figure 4.6 illustrates the correct way to use the well-nut. The rubber flange has to be flushed on the roofline. The Z-Bracket, along with the flat washer and lock washer, hold the well-nut in place when the screw is fastened.

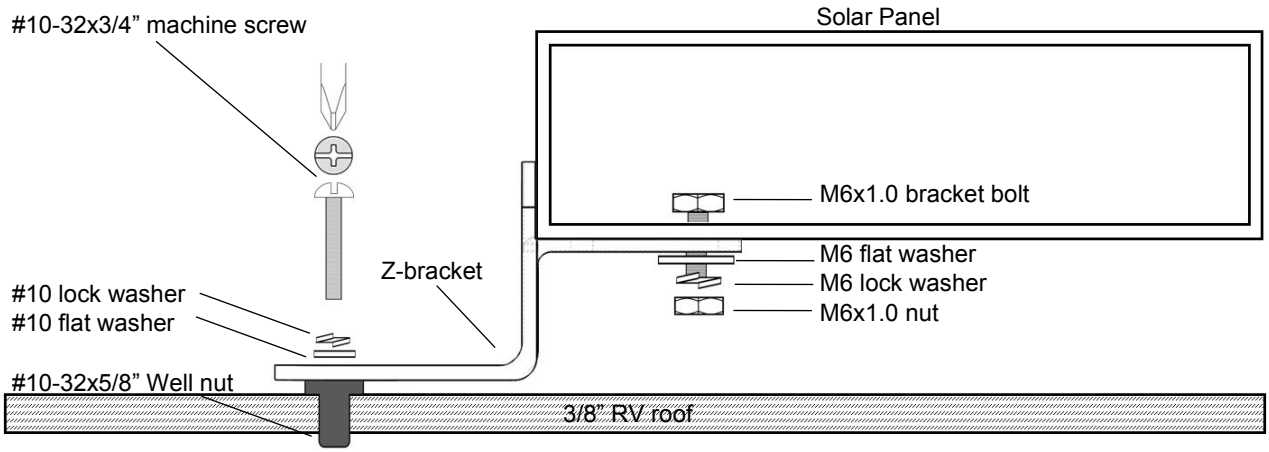

Figure 4.6 RV overall mounting structure with hardware description

Gently insert the well nut into the drill hole (**Figure 4.6**). Be careful not to push the well nut flange completely into the holes. Make sure the flange is flushed on the roofline.

Before attaching the panel to the roof, a film of caulk can be laid between the RV roof and the Z-Bracket. Even though the well-nut provides a watertight bond, this provides additional sealant.

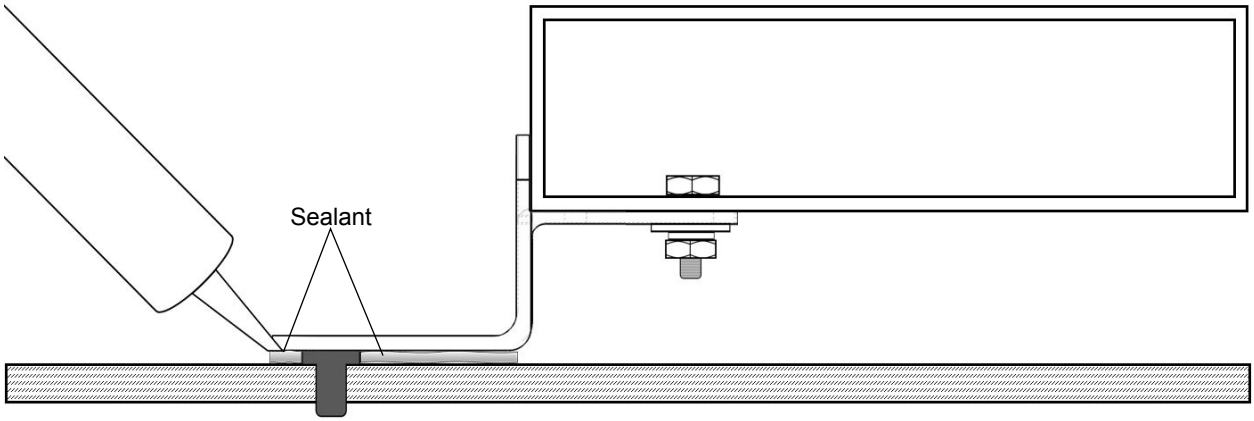

Figure 4.7 Applying sealant under Z-Bracket

Once the caulking sealant bead has been laid, align the Z-Brackets with the well nut holes. Insert the #10 lock washer into the #10-32x3/4” machine screw followed by the #10 flat washer. **Apply anti-seize fluid to the screw, as this will prevent galling, locking, or seizing with the well-nut brass insert.**

Insert the screw into the well-nut hole, and begin to tighten it with a Philips screwdriver. If the machine screw is has a combination drive head, then use a flat head screwdriver. As the screw is tightened, the well-nut compresses and expands, creating a secure strong hold that is free from air and water leakage (as shown in **Figure 4.8**).

Warning!

Do not over-tighten the screw. Do not exceed 5 in-lbs of torque.

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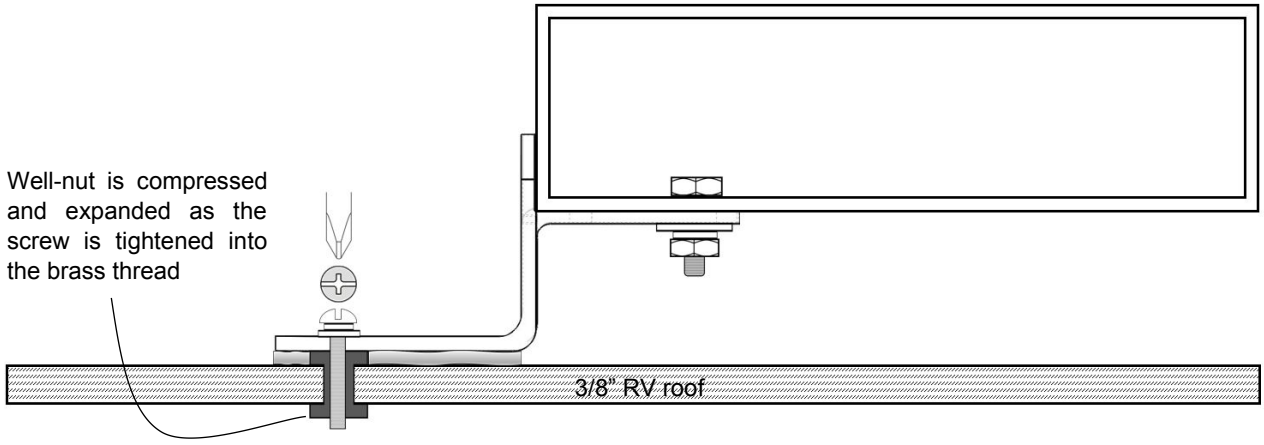

Figure 4.8 Finalized Z-Bracket on RV

Once you have tightened all the screws, ensure that the panel is secured before driving the RV. To finalize the RV mounting installation, cover the head screws and Z-Brackets with sufficient sealant; this will completely seal the base of the Z-Bracket.

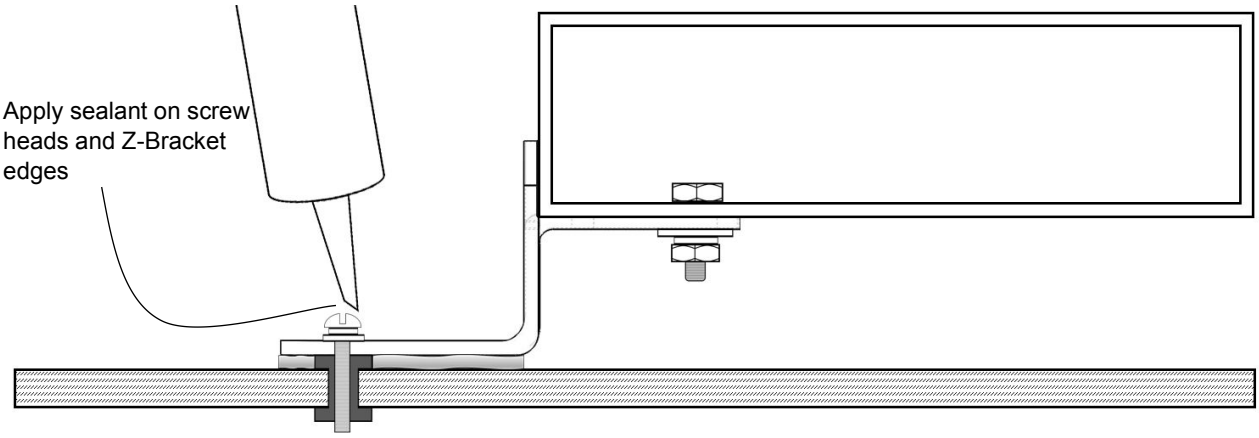

Figure 4.9 Sealing the Z-Bracket with sealant recommended and approved by an RV dealer.

Well-nuts and blind holes

The well-nut does not only work for thin RV roofs, but also works in blind holes. Tightening a well-nut in a blind hole will cause the body to expand and apply pressure against the walls of the hole. This also creates a secure hold of the solar module.

Using the Z-Brackets on a house roof

The Z-Brackets can also be used on a house roof if the proper roof penetration sealant is used between the roof and the Z-Bracket. **Figure 4.10** shows a 60W (RNG-60D) panel mounted into a shingle roof with Z-Brackets. A roof penetration sealant is necessary, as water might leak into the house if the holes are not properly sealed.

Figure 4.10 RNG-60D on a roof

The panels can also be mounted in custom mounting systems. **Figure 4.11** shows a homemade mounting frame made of a wood pallet. This is a great example of DIY off-grid work. Customers are not limited to mounting the panel on a RV or residential rooftop; they can also freelance on the design of their mounting system.

Figure 4.11 RNG-100D mounted on wood stand

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4.2 RENOGY Rail Mount System

The RENOGY Rail Mounting System is not only available for large 24V panels, but also available for smaller 12V panels such as the RENOGY 70W and 100W modules.

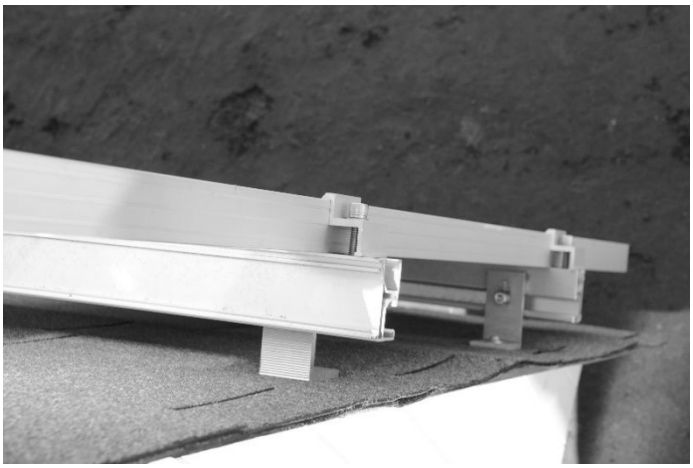

Figure 4.12 RNG-100D with Rail Mount

For roofs with asphalt shingles, RENOGY offers:

- Mid-clamps
- End-clamps for 12V panels
- L-feet
- Quick Mount PV ® Flush mounts
- 5 and 10 ft. rails
- Splices

Figure 4.13 Rail Mount components

Rail Mounting offers the capability of mounting multiple solar panels side by side. If greater length is necessary, the 5 ft. and 10 ft. rails can be extended with splices. Keep in mind that the thickness of each solar module is different; therefore, the correct End-clamp must be ordered.

4.3 RENOGY Single panel pole mount system

RENOGY offers a single panel pole mount system for 4” diameter poles. This mounting system is compatible with all Renogy 12V solar panels including the RNG-50D, RNG-50P, RNG-70P, RNG-100D and RNG-100P.

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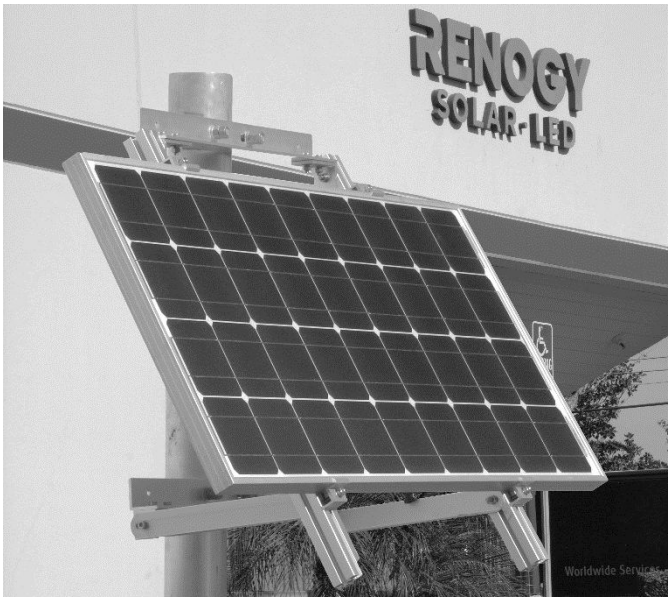

Figure 4.14 Pole mount system with RNG-100D

To find out more about RENOGY Mounting Systems please visit	**http://goo.gl/9C21Ke**
Or scan the following QR code with your smartphone:	

5 MC4 CONNECTORS

The Positive (+) and Negative (-) outputs of a solar panel are fed through a watertight junction box. The appropriate wire length is wired to the junction box for further connections. The solar panels supplied in each kit are provided with approximately 3 ft. each of both Positive and Negative wires that are pre-connected to the junction box. The free ends of the wires are terminated with a special type of mating connector also known as an MC4 Connector. These connectors allow for ease in extending the wires for further connections.

Caution!

Please do not cut off the solar panel connectors; the warranty will be voided.

5.1 General information about MC4 connectors

Each RENOGY Solar Panel will have an MC4 Connector System that consists of male and female connectors. This type of connector system is easy to install and uses a “snap-in” type of safety locking clips to lock the two mating connectors. The “snap-in” feature avoids unintentional disconnection. The mating contacts are sealed against the ingress of dust and water. Specifications are as follows:

- Contact diameter: 4 mm
- Maximum rated current: 30A
- Maximum system voltage: 1000V
- Gauge size: 14, 12, 10 AWG
- Degree of ingress protection when connected and properly locked: IP67

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- Temperature range: −40°C to +90°C
- TÜV Rheinland approved

5.2 General information about MC4 Connectors

The MC4 Connectors mentioned in this manual have been designated “Male” and “Female” ends based upon the characteristics of the mating contact inserts within the terminals. However, in the solar industry, the “Female” MC4 Connector is used for the **positive (+)** lead of a panel, and the “Male” MC4 Connector its used for the **negative (−)** lead of a panel as shown in Figure 5.2.

Figure 5.1 MC4 Connectors and mating contacts

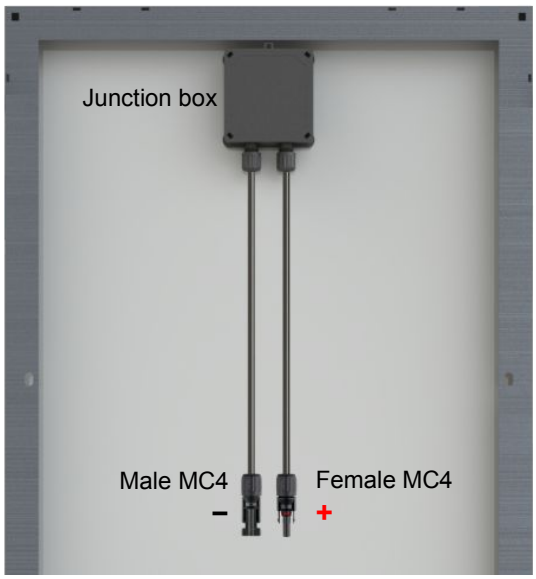

Figure 5.2 Back view of RNG-100D

Figure 5.2 shows the MC4 Connectors that come preassembled with each **RENOGY** solar panel. When purchasing unassembled MC4 Connectors for custom cabling, it is recommended that the appropriate crimper is used; this will avoid loose connections and create a strong internal contact when mating the MC4 Connectors. An example of a great crimping tool is shown in **Figure 5.3.**

Figure 5.3 Crimping tool (#14-10 AWG)

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6 12V WIRING

In this section, we will show the basic 12V and 24V connections for off-grid systems that use a PWM- type controller. Please follow them thoroughly.

Caution!

The battery must first be wired to the charge controller before the solar panel is connected to the charge controller.

6.1 Battery to charge controller

The battery(s) must first be connected to the charge controller before proceeding to any other connections. Most PWM Controllers have automatic battery voltage detection, and the controller must detect what voltage level it will be charging at.

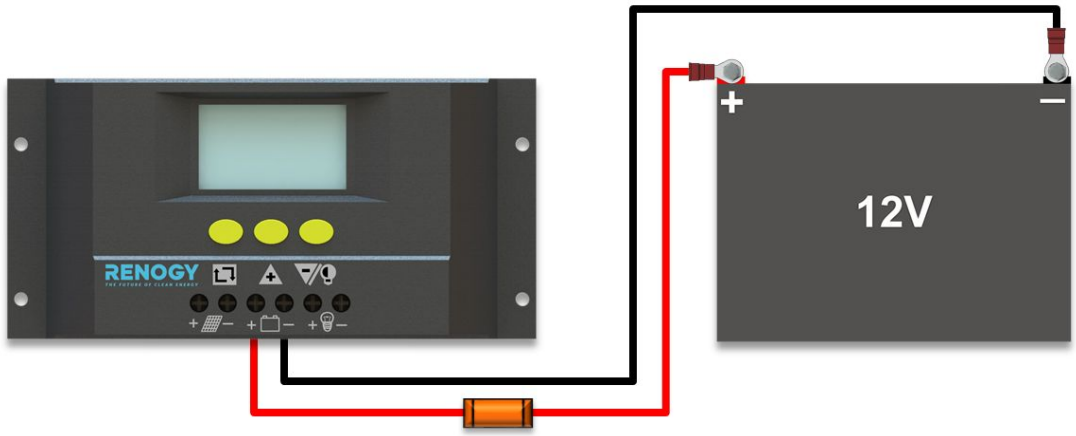

Figure 6.1 Charge controller connected to a 12V battery

Before starting the connection, keep in mind the following:

- The charge controller should be as close as possible to the batteries. This helps keep line loss to a minimum level.
- Remember to always use the recommended gauge size based on the input current. The PWM 30A LCD Controller can handle gauges up to 8 AWG.

NEC maximum current for different copper wire sizes

AWG	16	14	12	10	8	6	4	2	0
Max. Current	10A	15A	20A	30A	55A	75A	95A	130A	170A

Refer **to Figure 6.1** for connections.

1. First, connect the negative cable to the **negative (−)** battery post. The best way to secure the battery cable to the battery post is by using a **ring terminal**. A bolt is sufficient to secure the ring terminal onto the battery post; doing so will allow for great electrical contact. Next, connect the bare stranded portion of the cable to the **negative (−)** battery input terminal on the charge controller.
2. Similarly to the instructions described above, connect the positive cable to the **positive (+)** battery post. For protection, an in-line fuse can be added to this cable. This is usually done with a fuse holder. If opting for an in-line fuse, please do the following before connecting the **positive (+)** cable to the charge controller:

    - Make sure the fuse holder's gauge wire size is matched.
    - Attach the fuse holder to the line with a butt connector or by soldering it.

3. Once the fuse holder is in place, don't attach a fuse just yet. Connect the bare stranded portion of the cable to the **positive (+)** battery terminal on the charge controller.
4. The fuse can be sized according to the amount of panels in parallel for a PWM Controller. In other words, current in would be current out. Here is a formula to calculate the fuse size:

Controller to Battery Fuse = (Number of Panels in Parallel) × (Short Circuit Current of Panel) × 1.25

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Example: 200W Kit (2 Panels)

RNG-100D has a short circuit current of 5.75 amps, hence:

Controller to Battery Fuse = (2) × (5.75A) × 1.25 = 14.38A ≈ **15A**

5. Once the fuse is properly sized, ensure that all connections were made properly, and that there are no loose connections present. Finally, insert the fuse into the fuse holder. **The controller should power on.**
6. If opting for **no in-line fuse**, connect the bare stranded portion of the cable to the **positive (+)** battery input terminal on the charge controller directly from the **positive (+)** battery post, bypassing the fuse holder. **The controller should power on.**

Warning!

Be careful not to short the battery. Reverse polarity connection will damage the charge controller and the resulting damage will not be covered by warranty.

6.2 Information about solar panels and PWM Controllers

When connecting a solar panel to the charge controller, please ensure that the correct type of panel or panel array is used.

Please note the following about PWM Controllers:

- 12V panels should be used with 12V battery systems only
- 24V panels or 12V panels configured in series to make 24V should be used with 24V battery systems only
- The solar array should not max out the rated power of the controller. Failure to obey this rule may result in the controller overheating or catching fire.

6.3 Extending the output wires of the solar panel

As we explained in the previous section, **RENOGY** Solar Panels are equipped with cables terminated by MC4 Connectors. To extend these cables, **RENOGY** provides adapter kits as shown in **Figure 6.2**. Adapter kits can be found in Complete Solar Kits or sold as separate components at www.renogy-store.com.

Fig. 6.2. MC4 Adapter Kit

Adapter kits are sold in different lengths, and the basic gauge size is #12 AWG. Unassembled MC4 Connectors can also be purchased separately to make a custom adapter cable suitable for different length specifications.

Caution!

The typical connection for 12V panels using a PWM Controller is a **parallel connection**. This connection increases the current, but keeps the voltage level the same. When placing multiple panels in parallel, it is necessary to size the wire gauge accordingly, and keep the distance between the solar array and the controller as **close as possible**.

Long runs of cable between the panel(s) and the controller increase the line loss if the gauges are not properly sized. We recommend keeping the distance between the solar array and the controller as close as possible. **RENOGY** provides a gauge-sizing tool, available for no charge at:

http://www.renogy-store.com/category-s/1864.htm

Please refer to **Figure 6.3**. This figure shows the extending of the output wires of the RNG-100D Solar Panel using the adapter kit. The polarity labeled on the panel's leads should be the only ones to follow. When adapting the leads, mark the **positive (+)** cable; doing so will avoid reverse polarity when connecting the panel(s) to the controller.

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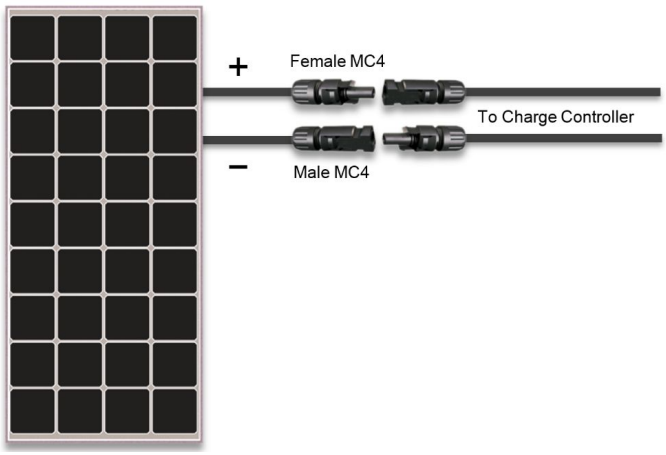

Figure 6.3 Solar panel and adapter kit

6.4 Solar Panel to charge controller

Once the battery is connected to the charge controller and the panel(s) are positioned and mounted in the desired location, we are ready to connect the panel(s) to the charge controller. Panels should be mounted in a place that is free from shading by neighboring obstacles such as vents, air-conditioners, TV antennas, etc.

Hazard!

The panel MUST be covered with a dark cloth to prevent the solar cells from producing energy; this will prevent and reduce shock hazard, which can be life threatening.

Please refer to **Figure 6.4** when completing the following connections:

1. First, mate the “Male” MC4 Connector from the solar panel that has the **negative (−)** label with the “Female” MC4 Connector of your adapter kit as shown in **Figure 6.4**. Then connect the bare stranded portion of the cable to the **negative (−)** solar input terminal on the charge controller.
2. Next, mate the “Female” MC4 connector from the panel that has the **positive (+)** label with the “Male” MC4 connector of your adapter kit as show in **Figure 6.4**.
3. The **positive (+)** solar cable can be fused for protection; an in-line fuse can be added to this cable in the same way as described in the instructions for battery to controller connection. Please refer to section 6.1 and follow the same procedure to find the proper size of this fuse.
4. Once the fuse holder is in place, don’t attach a fuse just yet. Connect the bare stranded portion of the cable to the **positive (+)** solar terminal on the charge controller. Ensure that all connections are made properly, and that there are not any loose connections present. Finally, insert the fuse into the fuse holder and remove the protective cloth. If there is enough sunlight present, the controller’s solar LED indicator/icon on the LCD display should show that it is now charging your battery(s).
5. If opting for **no in-line fuse**, connect the bare stranded portion of the adapter cable to the **positive (+)** solar input terminal on the charge controller. Remove the protective cloth. If there is enough sunlight present, the controller’s solar LED indicator/icon on the LCD display should show that it is now charging your battery(s).

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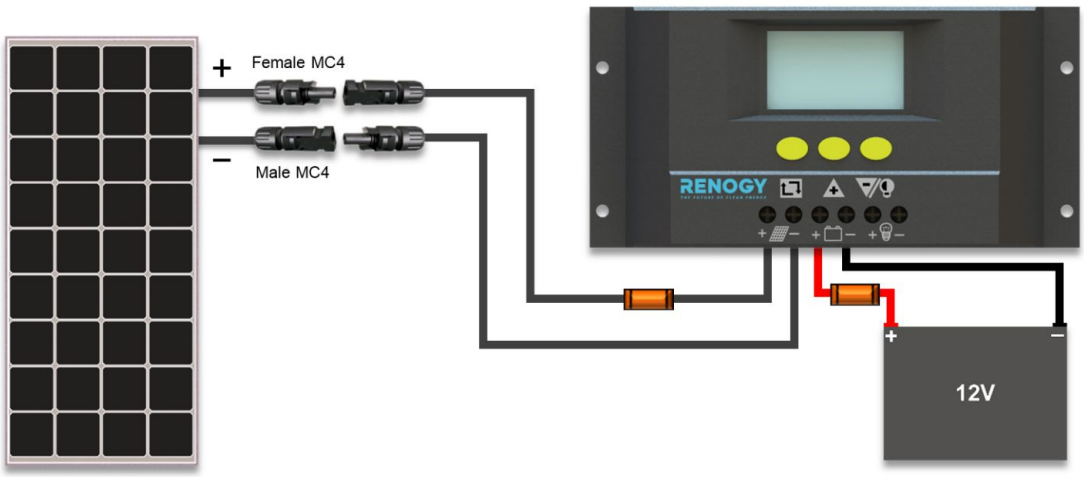

Figure 6.4 Completed 12V off-grid system

Figure 6.4 shows the complete wiring of a typical off-grid system. It includes fuses for safety and protection. This configuration shows only one panel and one battery connected to the controller. In **Sections 8 and 9,** more panel and battery configurations (respectively) will be described. Instructions will follow.

7 24V WIRING BASICS

7.1 General information

In this section we will show the basic connections for a 24V battery system. Please follow them thoroughly.

Caution!

The batteries must first be wired to the charge controller before the solar panel is connected to the charge controller.

As we mentioned in Section 6.1, the battery bank must first be connected to the charge controller before any other connections are made. This will allow the controller to set the 24V charging parameters automatically.

Before starting the connections keep in mind the following:

- The charge controller should be as close as possible to the batteries. This helps keeping line loss to a minimum level.
- Remember to always use the recommended gauge size based on the **total** input current. The PWM 30A LCD controller can handle gauges up to 8 AWG.

NEC maximum current for different copper wire sizes

AWG	16	14	12	10	8	6	4	2	0
Max. Current	10A	15A	20A	30A	55A	75A	95A	130A	170A

Please note the following about PWM controllers running in 24V configuration:

- 24V panels or 12V panels configured in series to make 24V should be used with 24V battery system only
- It is not recommended that you charge a 12V battery system with a 24V solar array. Doing so will result in a performance loss of 50%.
- The solar array should not max out the rated power of the controller. Failure to obey this rule may result in the controller overheating or catching fire.

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7.2 Overall system connections

Please refer to **Figure 7.1** for the overall wiring diagram for a 24V system.

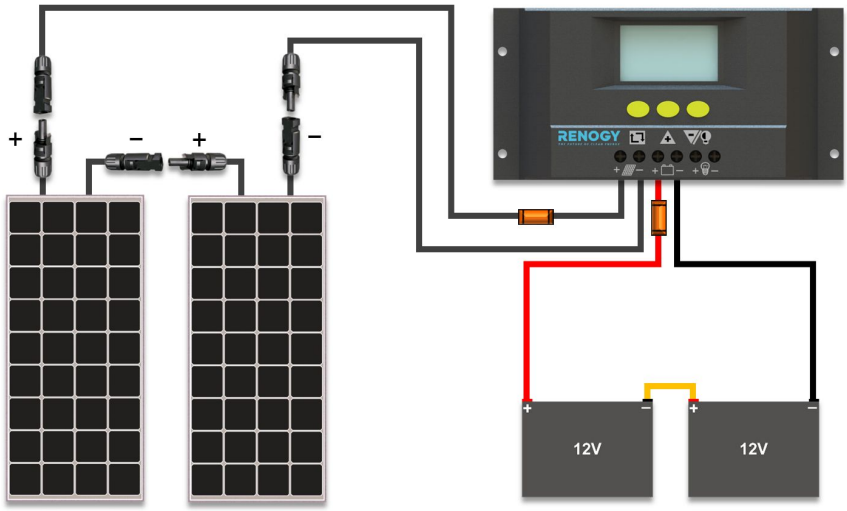

Figure 7.1 Completed 24V off-grid system

As you can see from **Figure 7.1**, the batteries are configured in 24V by placing two **identical** 12V batteries in series. Likewise, the solar array is configured in 24V by placing two **identical** 12V panels (e.g. RNG-100D) in series.

The connections for a 24V off-grid system are very similar to the 12V connections. The process should be followed in the same way as outlined in Sections 6.1 to 6.4. The only difference in instruction is that the fuses are now calculated by the number of parallel strings. A string is a set of panels configured in series. **Figure 7.1** shows a single string that consists of two 12V panels in series.

Remember, when configuring the panels in series, the voltages will add and the amperage in the current loop will remain the same. For this reason, we can see a slight change in the fuse equation:

Controller to Battery Fuse = (Number of strings in Parallel) × (Short Circuit Current of Panel) × 1.25

With this being said, the same steps for a 12V system should be followed. Please read Sections 6.1 to 6.4.

8 MULTIPLE PANELS/STRINGS IN PARALLEL

A parallel connection is achieved by joining all of the positive (+) and negative (-) nodes together. When placing panels in parallel, it is recommended that the voltage levels are within specification. In other words, the V_{mp} (maximum power voltage) of the panels must all be within 10% of each other. Typically, connecting panels in parallel is achieved through using **identical** panels. A simple way to place panels/strings in parallel is by using a branch connector, shown in **Figure 8.1**.

Figure 8.1 Pair of MC4 Branch Connectors

Caution!

Remember to always use the recommended gauge size based on the **total** array current. Sizing the cable incorrectly may result in melting wires and/or fire.

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8.1 Two adjacent panels in parallel (12V systems)

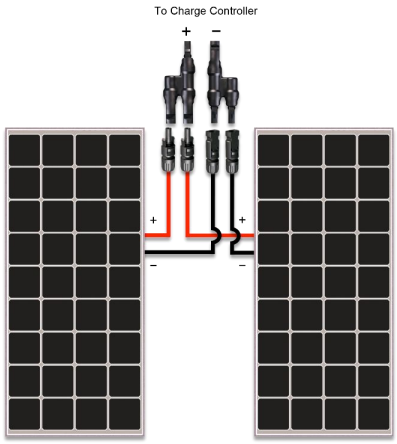

Figure 8.2 Two RNG-100D Panels in parallel

One of the most basic solar configurations involves wiring two solar panels in parallel. This parallel configuration will increase the current output while the output voltage remains the same. **Fig. 8.2** above shows the arrangement for connecting two solar panels in parallel with one pair of MC4 Branch Connectors. This arrangement is applicable if two solar panels will be mounted adjacent to one another. This connection requires **one (1)** pair of MC4 Branch Connectors. When the panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).

8.2 Three adjacent panels in parallel (12V systems)

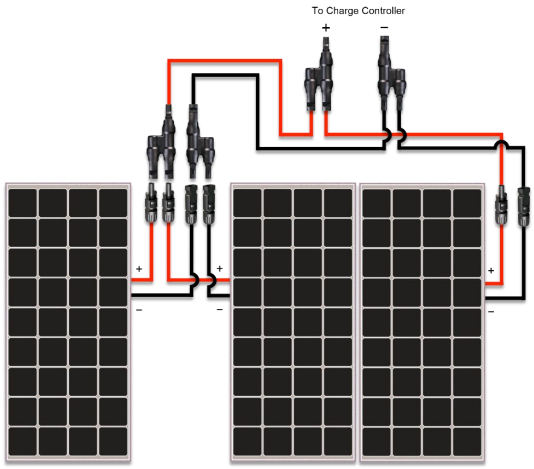

Figure 8.3 Three RNG-100D Panels in parallel

Three solar panels is the maximum amount of panels that can be connected in parallel if they are adjacent to one another, without using extra cabling. **Fig. 8.3** above shows the arrangement for connecting three solar panels in parallel. Remember that this arrangement is applicable if the three solar panels are to be mounted adjacent to one another. This connection requires **two (2)** pairs of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels need to be extended with MC4 Extension Cables (sold separately).

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8.3 Four panels in parallel (12V systems, 2x2 configuration)

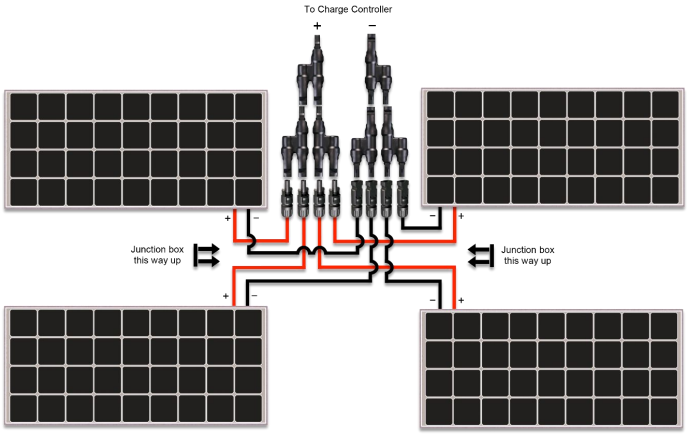

Figure 8.4 Four RNG-100D Panels in parallel

Fig. 8.4 shows the arrangement for connecting four solar panels in parallel. This arrangement is applicable if the solar panels are to be mounted in a **2x2** configuration as shown above. Please note that the positioning of the junction boxes must be followed for the cables to reach the MC4 Branch Connectors. This connection requires **three (3)** pairs of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).

8.3 Four panels in parallel (12V systems, 1x4 configuration)

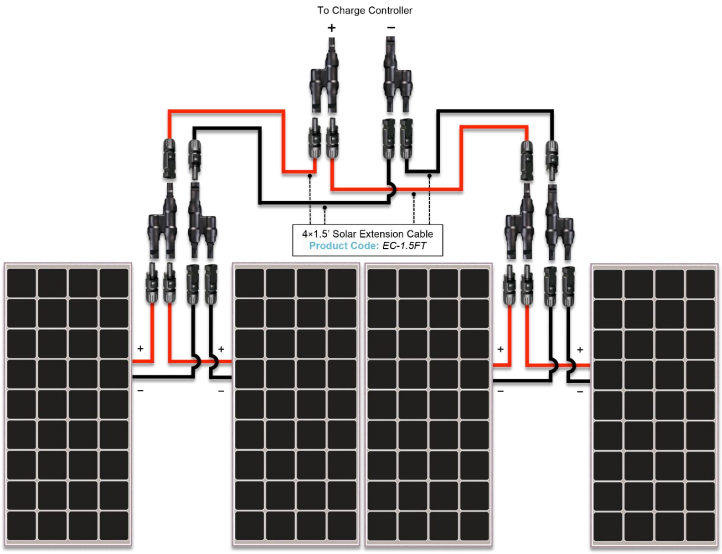

Figure 8.5 Four RNG-100D Panels in parallel

Fig. 8.5 above shows the arrangement for connecting four solar panels in parallel. This arrangement is applicable if the solar panels are to be mounted in a **1x4** configuration as shown above. For this configuration you will need to purchase 4x1.5' MC4 Solar Extension Cables. This connection requires a **three (3)** pairs of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).

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8.4 Four panels in series-parallel (24V systems, 2x2 configuration)

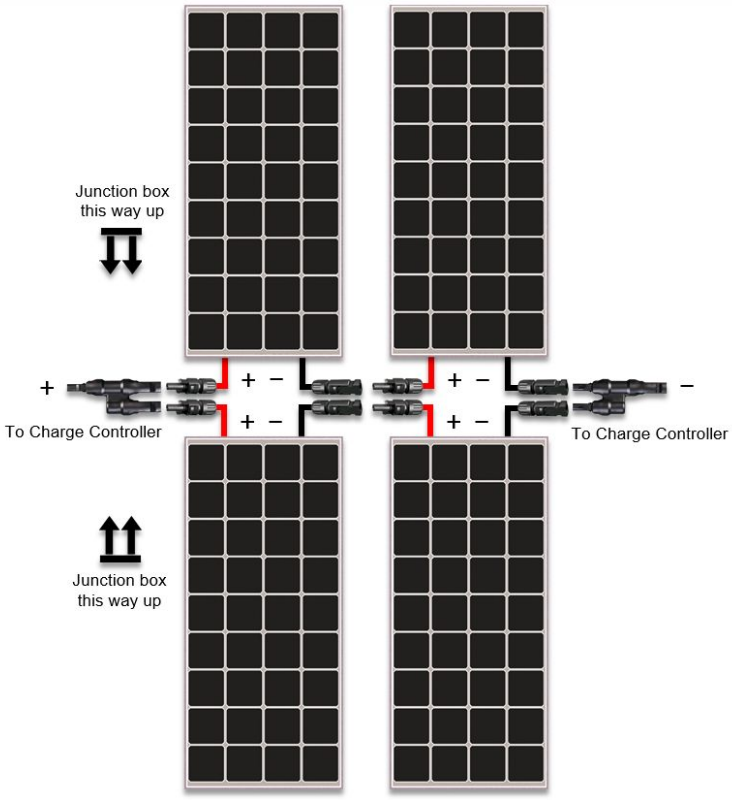

Figure 8.6 Four RNG-100D Panels in series-parallel configuration

For 24V systems, **Fig. 8.6**. Shows two strings of panels in parallel. Each string consists of two panels in series. No additional cabling is required if the solar panels are to be mounted in a **2x2** configuration as shown above. Please note the orientation of the junction boxes. This connection requires a **one (1)** pair of MC4 Branch Connectors. When one or multiple panels are mounted at different locations- that is, separated by a distance, the panels must be extended with MC4 Extension Cables (sold separately).

Note

This 24V array can only be used with a 24V battery configuration when using a PWM Controller. Please do not use it with a 12V battery system.

9 BATTERY CONFIGURATIONS

The battery system can also be configured to create a “bank” of batteries. In this section, we cover the most basic configurations. When wiring batteries, extreme attention should be given. Never short a battery, as high currents can cause severe burns or even death.

Hazards!

It is recommended that insulated/non-conducting tools be used when working with batteries. Never leave tools on top of the battery. Always wear eye protection. Never touch both of the battery terminals at the same time with your bare hands.

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9.1 Series connection of batteries (12V)

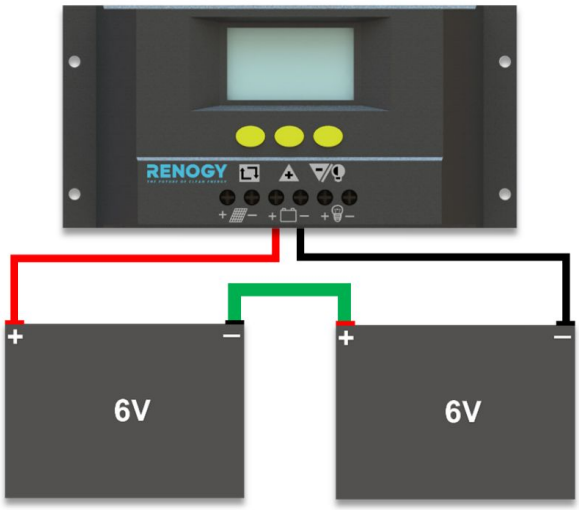

Figure 9.1 Two 6V batteries connected in series

When two or more batteries are connected in a series, their voltages add up, but the Amp-Hour (AH) capacity remains the same. **Fig. 9.1** shows two 6V batteries in parallel. For example, say each battery has 225 Ah. This wiring will form a 12V battery bank with a capacity of 225 Ah. Notice that the cables connecting the batteries in series are of heavier gauge than the ones coming from the controller. These cables have to be of heavier gauge because when power is drawn from an inverter, it involves large amounts of current. This interconnection cable is often sized according to the power of the inverter.

9.2 Parallel connection of batteries (12V)

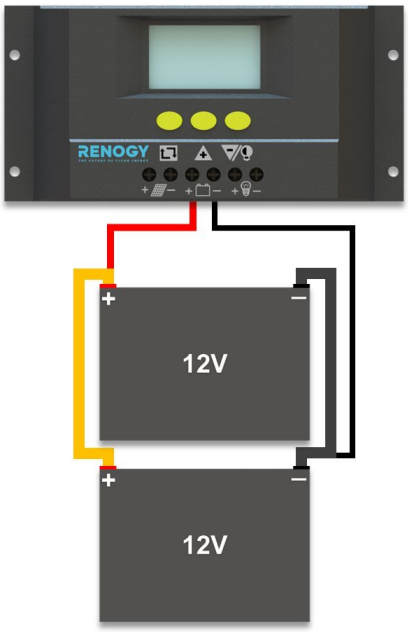

Figure 9.2 Two 12V batteries connected in parallel

When two or more batteries are connected in parallel, their voltage remains the same but the Amp-hour ratings add up. **Fig. 9.2** shows two 12V batteries in parallel forming a “bank”. For example, say each battery has 100 Ah. When connected in parallel they will form a battery bank of 12V with a capacity of 200 Ah. Notice that the cables connecting the batteries in parallel are of heavier gauge than the ones coming from the controller. These cables have to be of heavier gauge because when power is drawn from an inverter, it involves large amounts of current. This interconnection cable is often sized according to the power of the inverter.

The negative cable from the controller to the battery should be placed at the opposite end of the battery bank. **Figure 9.2** shows this connection.

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9.3 Series – Parallel connection of batteries (12V)

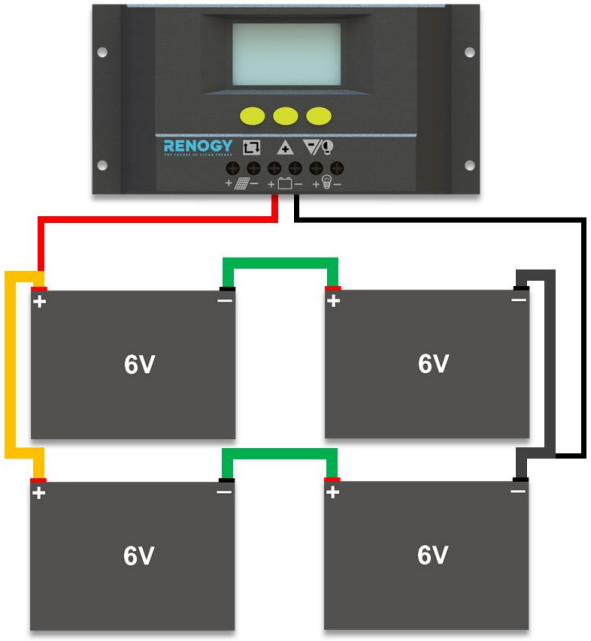

Figure 9.3 Four 6V batteries connected in series – parallel

Fig. 9.3 shows two strings in parallel; each string consists of two 6V batteries in series. For example, say each battery has 225 Ah. Each string would have a voltage of 12V with a capacity of 225 Ah. When these strings are paralleled, the total capacity of the battery bank will be 12V at 450Ah. Notice that the cables connecting the batteries in series and parallel are of heavier gauge than the ones coming from the controller. These cables have to be of heavier gauge because when power is drawn from an inverter, it involves large amounts of current. This interconnection cable is often sized according to the power of the inverter. Also, the negative cable from the controller to the battery should be placed at the opposite end of the battery bank. **Figure 9.3** shows this connection.

9.4 Series connection of batteries (24V)

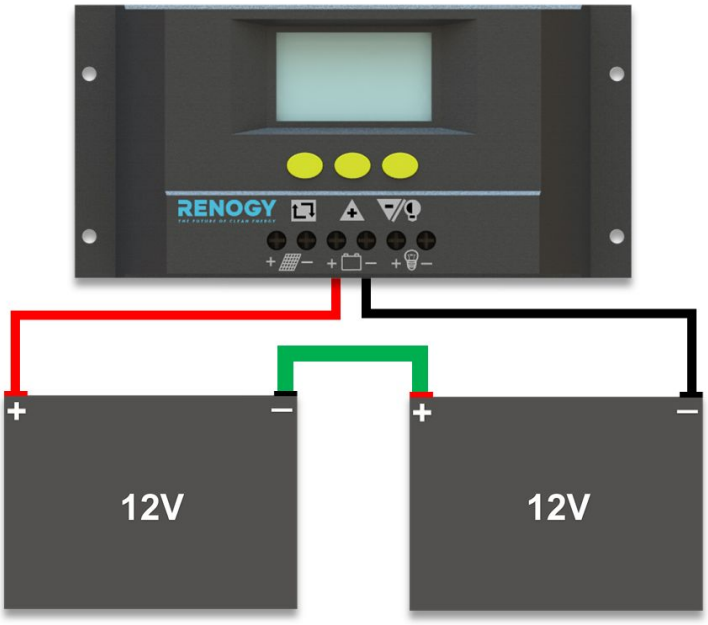

Figure 9.4 Two 12V batteries connected in series

Wiring two 12V batteries in series as shown in **Fig 9.4** will result in a 24V system. The same idea applies if you place four 6V batteries in series (**Fig 9.5**). Remember that when batteries are in series, the voltages add, but the total capacity of a string of batteries stays the same. For example, if two 12V batteries with 150Ah rating are wired in series, the resulting system would be 24V at 150Ah. **Because of this, it is mandatory that the batteries are identical when they are wired in series.**

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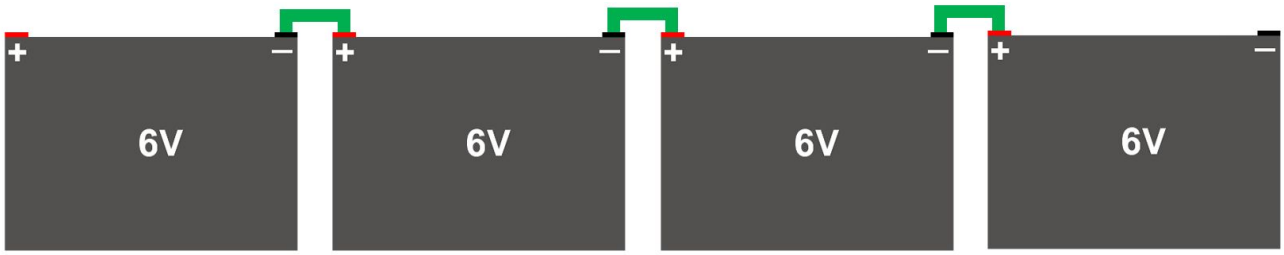

Figure 9.5 Four 6V batteries connected in series

9.5 Series-Parallel connection of batteries (24V)

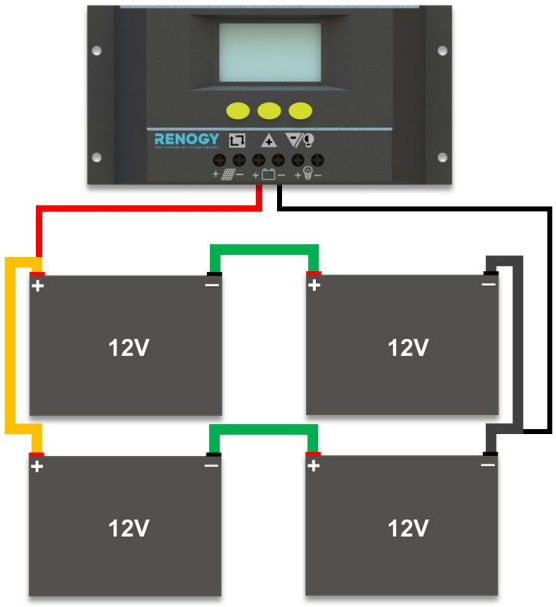

Figure 9.6 Four 12V batteries connected in series – parallel

Multiple strings of batteries can be wired in parallel to increase the capacity. **Figure 9.6** shows a battery bank with two strings of batteries. Each string consists of two 12V batteries in series. For example, if wiring four 12V/150Ah batteries like as shown in Figure 9.6, then each string will have a total capacity of 24V/150Ah. By paralleling these strings, the total capacity would be 24V/300Ah. **Because of this, it is mandatory that the batteries are identical.**

Each parallel string can also consist of 4x6V batteries to make 24V per string as shown in **Figure 9.5**. Remember that the negative cable from the controller to the battery should be placed at the opposite end of the battery bank.

10 INVERTER WIRING

10.1 General information about power inverters

A power inverter, or inverter, is an electrical device that changes direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits.

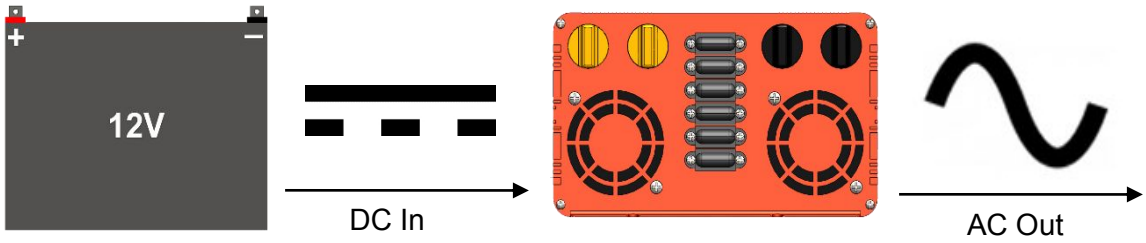

Figure 10.1 Simple diagram on how the inverter works

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Warning!

Please read these instructions carefully before attempting to carry out any installation and wiring. Contact Technical support for any questions concerning the installation.

This equipment should be installed, adjusted, and serviced by qualified electrical maintenance personnel familiar with the construction and operation of solar/electrical equipment and the hazards involved. Failure to observe this precaution may result in bodily injury and/or damage to property.

10.2 Wiring instructions

Step 1: Select the right input voltage

Input voltage can be 12V/24V/48V depending on which products are used. It is recommended that the inverter be powered by a battery or battery bank, as the current drawn from the inverter can become extremely high.

Step 2: Connecting inverter to battery

Set the switch to **OFF** position (inverter and appliances). Connect the battery cables to their respective colors on the inverter i.e. black cable goes to the black terminal on the inverter, and the red cable goes to the red terminal on the inverter.

Please refer to **Fig. 3**. Each end of the battery tray cables should have a "ring terminal" type of connector. These connectors make it easy to achieve a secure and strong connection. Once the cables are connected and bolted down to the inverter, connect the black cable to the negative post of the battery (-). Then, connect the red cable to the positive post of the battery (+). If connecting to a battery bank, make sure that the black cable connects to the negative battery post (-) at the end of the bank (opposite to the positive battery post as shown on **Fig. 3**). It is recommended that a fuse be placed on the hot line (positive) between the battery and inverter. Please refer to **the owner's manual** for the proper wire gauge size and fuse ratings for each inverter.

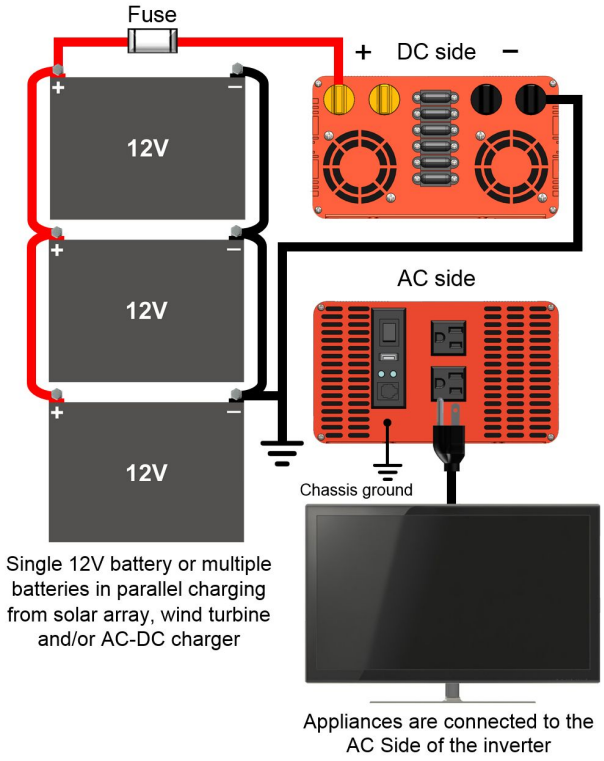
Fuse
+ DC side −
12V
12V
12V
AC side
Chassis ground
Single 12V battery or multiple batteries in parallel charging from solar array, wind turbine and/or AC-DC charger
Appliances are connected to the AC Side of the inverter

Figure 10.2 Inverter wiring diagram

Ground!

The negative battery terminal and the chassis ground of the inverter should be connected to a system ground. This is a safety measure to prevent electrical shock!

NOTE: **The charge controller and the inverter should be connected to the same battery terminals (same connecting points shown in Figure 10.2), no exceptions.**

Step 3: Connecting electrical appliances to inverter

Caution!

Make sure the power load is within the rated power of the inverter. The start power of the appliances should not exceed the peak power of the inverter.

Once the devices are connected to the AC outlet, they are ready to be powered. When the inverter is not in use, it is recommended that you turn off the inverter (switch in **OFF** position).

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11 WARRANTY

By acquiring the products of RNG Group Inc. ("Renogy"), you have purchased quality. As a sign of confidence in this quality, we are pleased to grant you the following warranties and guarantees for our photovoltaic products:

LIMITED WARRATNY: Renogy warrants these products will be free from defects in material and manufacture for the following periods from the date of purchase:

- One (1) year **RENOGY** PWM Charge Controllers
- One (1) year on the rest of accessories
- Five (5) years on **RENOGY** Solar Panels (material and workmanship)
- 25 years power output warranty on **RENOGY** Solar Panels

This warranty extends only to the original purchaser. The Customer's sole and exclusive remedy and the entire liability of Renogy, its suppliers and affiliates for breach of the warranty is, either to replace the Product or component parts or to refund the purchase price of the Product. This warranty does not cover labor. Repaired or replaced products are warranted for the remainder of the original warranty period only. No employee, agent, dealer or other person is authorized to give any warranties on behalf of Renogy not expressly set forth in this limited warranty.

The warranty does not cover failures result from incorrect handling, product modifications, installation, conversion or additions, supplements, operation, natural elements, excessive or deficient energy supply, chemicals, the effect of solid bodies or deliberate damage. If Renogy determines that the problem with the Product is not due to a manufacturing defect in Renogy's workmanship or materials, or otherwise does not qualify for warranty repair, then the Customer will be responsible for the costs of all necessary repairs and expenses incurred by Renogy.

The warranty shall be asserted with Renogy in writing enclosing a copy of the invoice and a description of the defect/loss of performance within the warranty period. Renogy shall accept no returns of modules without the previous written request for this. Within five (5) business days of the date of notification, Renogy will provide the Customer with an RMA number and the location to which the Customer must return the defective Product. Any Product returned for warranty service shall be shipped at the expense and risk of the Customer. The Customer must return the entire Product (or, if authorized by Renogy, the defective component parts), within fifteen (15) days after issuance of the RMA number. Renogy will be under no obligation to accept any returned Product that does not have a valid RMA number. All parts that Renogy replaces shall become Renogy's property on the date Renogy ships the repaired Product or part back to the Customer. Renogy will use all reasonable efforts within thirty (30) days of receipt of the defective Product to repair or replace such Product. If a warranty claim is invalid for any reason, the Customer will be charged at Renogy's then-current rates for services performed and will be charged for all necessary repairs and expense incurred by Renogy. If Renogy determines that a warranty claim is valid, it will ship the repaired or replaced Product to Customer at Renogy's cost.

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